but inasmuch as part of them may be in a mobile fluid like air, and part of them in a solid like iron or steel, it is convenient to distinguish between their two portions; and one may think of the air whirls alone as reaching from one piece of iron to another and by their shortening tendency or centrifugal force pulling the two pieces together.

The arrangement shown in Fig. 31 illustrates the kind of force exerted by a spinning elastic framework along and perpendicular to its axis of rotation.

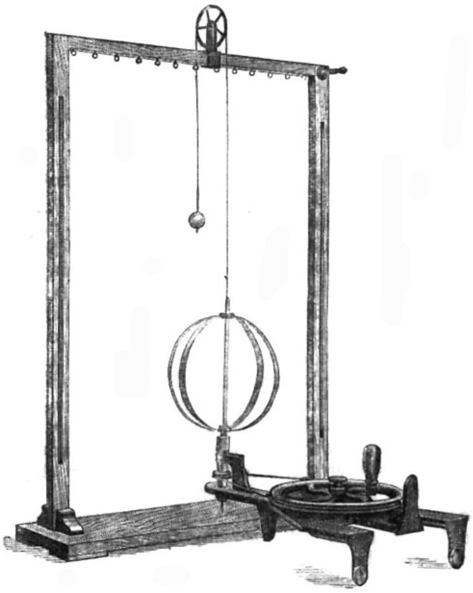


Fig. 31.—A "shape of the earth" model which, when whirled, exerts a tension along its axis, pulling up the weight attached to it, and a pressure at right angles, by reason of its bulging out.

One can easily see this effect of a whirl in a tea-cup or inverted bell-jar full of liquid. Stir it vigorously, and leave it. It presses against the walls harder than before, so that if they were elastic they would bulge out with the lateral pressure; and it sucks down the top or free end of its axis of rotation, producing quite a depression or hollow against the force of gravity. Or, as a more striking illustration, make the following apparatus.

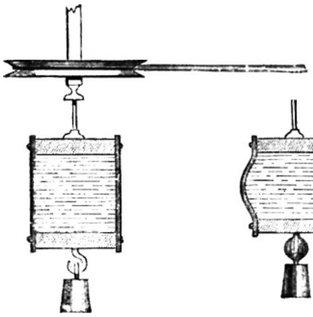
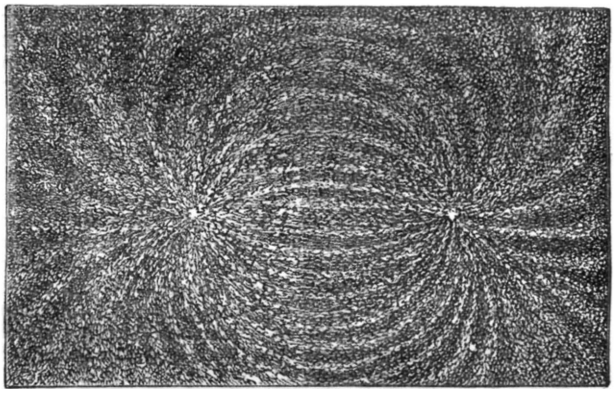


Fig. 32.—An elastic-walled cylindrical vessel full of liquid hanging from a whirling table, and, by reason of centrifugal force, raising a weight and bulging out laterally when spun, thereby illustrating a tension along the axis of rotation and a pressure in every perpendicular direction.

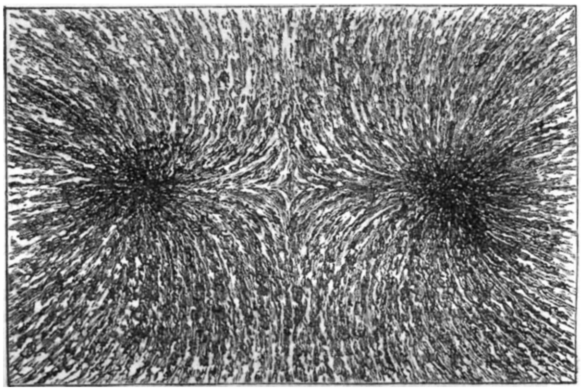
Two circular boards joined by a short wide elastic tube or drum: a weight hung to the lower board, the top board hung from a horizontal whirling table, the drum filled with water, and the whole spun round. The weight is raised by the longitudinal tension; the sides bulge out with the lateral pressure.

There is no need for the whole vessel to rotate. If the liquid inside rotates, the same effect is produced.

Imagine now a medium composed of a multitude of such cells with rotating liquid inside: let the cells be either very long, or else be joined end to end so as to make a chain—a series of chains side by side—and you have a picture of a magnetic medium traversed by a field of force. End-boundaries of the field will be dragged together, thus representing magnetic attraction; while, sideways, the lines of force (axes of whirl) squeeze each other apart, thus illustrating repulsion. This is Clerk-Maxwell's view of an electro-magnetic medium, and of the mode in which magnetic stress, and magnetic attractions and repulsions between bodies, arise.



Attraction.



Repulsion.

Fig. 33.—Attraction and repulsion. The tension along the lines of force or axes of rotation drags the one pair of poles together; and the pressure in directions perpendicular to the axis of rotation due to the centrifugal force of the whirls drives the other pair apart.

Wherever lines of force reach across from one body to another, those bodies are dragged together as if pulled by so many elastics (Fig. 33); but wherever lines of force from one body present their *sides* to those proceeding from another body, then those bodies are driven apart.

Oliver J. Lodge.

(*To be continued.*)

LANGUAGE-REASON.

THE inclosed letter on "Reason-Language" was written to an American friend, and has been published in an American paper in Chicago. I thought it might possibly interest the readers of NATURE.

Oxford, January 22. F. Max Müller.

"You tell me that my book on the 'Science of Thought' is thoroughly revolutionary, and that I have all recognized authorities in philosophy against me. I doubt it. My book is, if you like, evolutionary, but not revolutionary; I mean it is the natural outcome of that philosophical and historical study of language which began with Leibniz, and which during our century has so widely spread and ramified as to overshadow nearly all sciences, not excepting what I call the science of thought.

"If you mean by revolutionary a violent breaking with the past, I hold on the contrary that a full appreciation of the true nature of language and a recognition of its inseparableness from thought will prove the best means of recovering that unbroken thread which binds our modern schools of thought most closely together with those of the Middle Ages and of ancient Greece. It alone will help us to reconcile systems of philosophy hitherto supposed to be entirely antagonistic. If I am right—and I must confess that with regard to the fundamental principle of the identity of reason and language I share the common weakness of all philosophers, that I cannot doubt its truth—then what we call the history of philosophy will assume a totally new aspect. It will reveal itself before our eyes as the natural growth of language, though at the same time as a constant struggle of old against new language—in fact, as a dialectic process in the true sense of the word.

"The very tenet that language is identical with thought—what is it but a correction of language, a repentance, a return of language upon itself?

"We have two words, and therefore it requires with us a strong effort to perceive that behind these two words there is but one essence. To a Greek this effort would be comparatively easy, because his word *logos* continued to mean the undivided essence of language and thought. In our modern languages we shall find it difficult to coin a word that could take the place of *logos*. Neither *discours* in French, nor *Rede* in German, which meant originally the same as *ratio*, will help us. We shall have to be satisfied with such compounds as thought-word or word-thought. At least, I can think of no better expedient.

"You strongly object to my saying that there is no such thing as reason. But let us see whether we came honestly by that word. Because we reason—that is, because we reckon, because we add and subtract—therefore we say that we have reason; and thus it has happened that reason was raised into something which we have or possess, into a faculty, or power, or something, whatever it may be, that deserves to be written with a capital R. And yet we have only to look into the workshop of language in order to see that there is nothing substantial corresponding to this substantive, and that neither the heart nor the brain, neither the breath nor the spirit, of man discloses its original whereabouts. It may sound violent and revolutionary to you when I say that there is no such thing as reason; and yet no philosopher, not even Kant, has ever in his definition of reason told us what it is really made of. But remember, I am far from saying that reason is a mere word. That expression, 'a mere word,' seems to me the most objectionable expression in the whole of our philosophical dictionary.

"Reason is something—namely, language—not simply as we now hear it and use it, but as it has been slowly elaborated by man through all the ages of his existence on earth. Reason is the growth of centuries, it is the work of man, and at the same time an instrument brought to higher and higher perfection by the leading thinkers and speakers of the world. No reason without language—no language without reason. Try to reckon without numbers, whether spoken, written, or otherwise marked; and if you succeed in that I shall admit that it is possible to reason or reckon without words, and that there is in us such a thing or such a power or faculty as reason, apart from words.

"You say I shall never live to see it admitted that man cannot reason without words. This does not discourage me. Through the whole of my life I have cared for truth, not for success. And truth is not our own. We may seek truth, serve truth, love truth; but truth takes care of herself, and she inspires her true lovers with the same feeling of perfect trust. Those who cannot believe in themselves, unless they are believed in by others, have never known what truth is. Those who have found truth know best how little it is their work, and how small the merit which they can claim for themselves. They were blind before, and now they can see. That is all.

"But even if I thought that truth depended on majorities, I believe I might boldly say that the majority of philosophers of all ages and countries is really on my side (see 'Science of Thought,' pp. 31 *et seq.*), though few only have asserted the identity of reason and language without some timorous reserve, still fewer have seen all the consequences that flow from it.

"Some people seem to resent it almost as a personal insult that what we call our divine reason should be no more than human language, and that the whole of this human language should have been derived from no more than 800 roots, which can be reduced to about 120 concepts. But if I had wished to startle my readers I could easily have shown that out of these 800 roots one-half could really have been dispensed with, and has been dispensed with in modern languages (see 'Science of Thought,' p. 417), while among the 120 concepts not a few are clearly secondary, and owe their place in my list (*ib.* p. 619) merely to the fact that in Sanskrit they cannot be reduced to any more primitive concept. To dance, for, instance, cannot be called a primitive concept; perhaps not even to hunger, to thirst, to cook, to roast, &c. Only it so happens that in Sanskrit, to which my statistical remarks were restricted, we cannot go behind such roots as NÆRT, KSHUDH, TÆRSH, PA*K*, &c. It is in that limited sense only that such roots and such concepts can be called primitive. The number of really primitive concepts would be so alarmingly small that for the present it seemed wiser to say nothing about it. But so far from being ashamed of our modest beginnings, we ought really to glory rather in having raised our small patrimony to the immense wealth now hoarded in our dictionaries.

"When we once know what our small original patrimony consisted in, the question how we came in possession of it may seem of less importance. Yet it is well to remember that the theory of the origin of roots and concepts, as propounded by Noiré, differs, not in degree, but *toto cœlo* from the old attempts to derive roots from interjections and imitations of natural sounds. That a certain number of words in every language has been derived from interjections and imitations no one has ever denied. But such words are not conceptual words, and they become possible only after language had become possible—that is, after man had realized his power of forming concepts. No one who has not himself grappled with that problem can appreciate the complete change that has come over it by the recognition of the fact that roots are the phonetic expressions of the consciousness of our own acts. Nothing but this, our consciousness of our own repeated acts, could possibly have given us our first concepts. Nothing else answers the necessary requirements of a concept, that it should be the consciousness of something manifold, yet necessarily realized as one. After the genesis of the first concept, everything else becomes intelligible. The results of our acts become the first objects of our conceptual thought; and with conceptual thought, language, which is nothing if not conceptual, begins. Roots are afterwards localized, and made the signs of our objects by means of local exponents, whether suffixes, prefixes, or infixes. What has been scraped and shaped again and again becomes as it were ‘shape-her’,’ *i.e.* a shaft; what has been dug and hollowed out by repeated blows becomes ‘dig-her’,’ *i.e.* a hole. And from the concept of a hole dug, or of an empty cave, there is an uninterrupted progress to the most abstract concepts, such as empty space, or even nothing. No doubt, when we hear the sound of cuckoo, we may by one jump arrive at the word cuckoo. This may be called a word, but it is not a conceptual word, and we deal with conceptual words only. Before we can get at a single conceptual word, we have to pass through at least five stages :—

“(1) Consciousness of our own repeated acts.
“(2) *Clamor concomitans* of these acts.
“(3) Consciousness of that *clamor* as concomitant of the act.
“(4) Repetition of that *clamor* to recall the act.
“(5) *Clamor* (root) defined by prefixes, suffixes, &c., to recall the act as localized in its results, its instruments, its agents, &c.

“You can see from my preface to the ‘Science of Thought’ that I was quite prepared for fierce attacks, whether they came from theologians, from philosophers, or from a certain class of scholars. So far from being discouraged, I am really delighted by the opposition which my book has roused, though you would be surprised to hear what strong support also I have received from quarters where I least expected it. I have never felt called upon to write a book to which everybody should say *Amen*. When I write a book, I expect the world to say *tamen*, as I have always said *tamen* to the world in writing my books. I have been called very audacious for daring to interfere with philosophy, as if the study of language, to which I have devoted the whole of my life, could be separated from a study of philosophy. I have listened very patiently for many years to the old story that grammar is one thing and logic another; that the former deals with such laws of thought as are observed, the latter with such as ought to be observed. No, no. True philosophy teaches us another lesson—namely, that in the long run nothing is except what ought to be, and that in the evolution of the mind, as well as in that of Nature, natural selection is rational selection; or, in reality, the triumph of reason, the triumph of what is reasonable and right; or, as people now say, of what is fittest. We must learn to recognize in language the true evolution of reason. In that evolution nothing is real or remains real except what is right; nay, in it even the apparently irrational and anomalous has its reason and justification. Towards the end of the last century, what used to be called *Grammaire Générale* formed a very favourite subject for academic discussions; it has now been replaced by what may be called *Grammaire Historique*. In the same manner, *Formal Logic*, or the study of the general laws of thought, will have to make room for *Historical Logic*, or a study of the historical growth of thought. Delbrück's essays on comparative syntax show what can be done in this direction. For practical purposes, for teaching the art of reasoning, formal logic will always retain its separate existence; but the best study of the real laws of thought will be hereafter the study of the real laws of language. If it was really so audacious to make the identity of language and reason the foundation of a new system of philosophy, may I make the modest request that some philosopher by profession should give us a definition of what language is without reason, or reason without language? “F. M. M.”

FERDINAND VANDEVEER HAYDEN.

WE reprint from the American journal *Science* (January 6) the following article on Dr. Hayden, whose death we lately announced:—Prof. Ferdinand Vandeveer Hayden, M.D., Ph.D., LL.D., who died in Philadelphia on the morning of December 22, was born in Westfield, Mass., September 7, 1829. Early in life he went to Ohio. In 1850 he was graduated from Oberlin College, and soon afterward read medicine at Albany, N.Y., receiving his degree from the Albany Medical College in 1853. He did not begin the practice of medicine, but in the spring of the year of his graduation was sent by Prof. James Hall of Albany, with Mr. F. B. Meek, to visit the Bad Lands of White River, to make collections of the Cretaceous and Tertiary fossils of that region. This was the beginning of his explorations of the West, which continued with little interruption for more than thirty years.

In the spring of 1854, Dr. Hayden returned to the Upper Missouri region, and spent two years in exploring it, mainly at his own expense, although he was aided a portion of the time by gentlemen connected with the American Fur Company. During these two years he traversed the Missouri River to Fort Benton, and the Yellowstone to the mouth of the Big Horn River, and explored considerable portions of the Bad Lands of White River and other districts not immediately bordering upon the Missouri. The large collections of fossils he made were given partly to the Academy of Sciences in St. Louis, and partly to the Academy of Natural Sciences of Philadelphia.

As one of the members of the Geological Survey has recently said, these collections and researches mark the commencement of the epoch of true geologic investigation of the Great West. The collections attracted the attention of the officers of the Smithsonian Institution; and in February 1856, Dr. Hayden was employed by Lieut. G. K. Warren, of the United States Topographical Engineers, to make a report upon the region he had explored; so that the results of his labours during the three previous years were utilized by the Government. This report was made in March of the same year, and in May following he was appointed geologist on the staff of Lieut. Warren, who was then engaged in making a reconnaissance of the North-West. He continued in this position until 1859, when he was appointed naturalist and surgeon to the Expedition for the exploration of the Yellowstone and Missouri Rivers, by Capt. William F. Raynolds of the Corps of Engineers of the United States Army, with whom he remained until 1862. The results of his work while with Liutenant Warren were published in a preliminary report of the War Department, and in several articles in the Proceedings of the Academy of Natural Sciences of Philadelphia for the Years 1857 and 1858, and more fully in a memoir on the geology and natural history of the Upper Missouri, published in the Transactions of the American Philosophical Society, Philadelphia, 1862. This paper also included chapters on the mammals, birds, reptiles, fishes, and recent mollusca of the region in which his geological investigations were carried on. During this period also he found time to make notes upon the languages and customs of the Indian tribes with which he came in contact. These notes were embodied in “Contributions to the Ethnography and Philology of the Indian Tribes of the Missouri River,” published in the Transactions of the American Philosophical Society, Philadelphia, 1862; in a “Sketch of the Mandan Indians, with some Observations illustrating the Grammatical Structure of their Language,” published in the *American Journal of Science* in 1862; and in “Brief Notes on the Pawnee, Winnebago, and Omaha Languages,” published